

REMARKS

Applicant appreciates the thorough examination of the present application that is evidenced in the Official Action of September 2, 2005 (the "Official Action"). Applicant has cancelled claims 1, 15, 22 and 55-56. Applicant has amended Claims 11 and 16. For at least the reasons explained below, Applicant submits that the Claims, as amended, are patentable over the cited art.

Status of the Claims

In the Official Action, Claims 1 and 16-20 were rejected under 35 U.S.C. § 103(a) as obvious in light of United States Patent No. 6,056,820 to Balakrishna *et al.* (hereinafter "Balakrishna") and United States Patent No. 5,853,478 to Yonehara *et al.* (hereinafter "Yonehara"). Official Action, p. 2. Claims 1 and 16-22 were rejected under 35 U.S.C. § 103(a) as obvious in light of Balakrishna and EP 0 962 963 to Uchida *et al.* (hereinafter "Uchida"). Official Action, p. 4. Claims 1, 11-15 and 55-56 were rejected under 35 U.S.C. § 103(a) as obvious in light of United States Patent No. 5,753,038 to Vichr *et al.* (hereinafter "Vichr") and Balakrishna. Official Action, p. 5. Claims 1, 11-15 and 55-56 were also rejected under 35 U.S.C. § 103(a) as obvious in light of United States Patent No. 5,006,914 to Beetz (hereinafter "Beetz") and Balakrishna. Official Action, p. 8. Claim 1 was rejected under 35 U.S.C. § 103(a) as obvious in light of United States Patent No. 6,063,185 to Hunter (hereinafter "Hunter") and Balakrishna. Official Action, p. 7. Claims 1 and 55 were rejected under the judicially created doctrine of double patenting over claims 1 and 8 of U.S. Patent 6,706,114.

Claims 16-20 are Patentable Over Balakrishna and Yonehara

As explained in the Preliminary Amendment filed with the present application, Yonehara and Balakrishna cannot be properly combined. However, even if such references are combined, the combination does not teach or suggest each recitation of Claims 16-20.

Claim 16 has been amended to include, inter alia, the recitations of cancelled Claims 1 and 22. In particular, Amended Claim 16 recites (emphasis added):

16. A method of producing a silicon carbide boule having a substantially single polytype, the method comprising:

forcing nucleation sites on a surface of a silicon carbide seed crystal having the substantially single polytype to a predefined pattern; and

growing the silicon carbide boule utilizing physical vapor transport (PVT) so as to provide selective preferential growth of silicon carbide on the silicon carbide seed crystal corresponding to the predefined pattern;

wherein forcing nucleation sites comprises forming a pattern of material other than silicon carbide on a surface of the silicon carbide seed crystal thereby selectively exposing portions of the seed crystal to define the nucleation sites in the selectively exposed portions of the seed crystal;

wherein the pattern of material other than silicon carbide provides a pattern of regions having a reduced sticking coefficient than that of the exposed portions of the seed crystal; and

wherein the silicon carbide boule grows laterally above the material other than silicon carbide.

As discussed in the Preliminary Amendment, Yonehara does not disclose forcing nucleation sites of a surface of seed crystal to a predetermined pattern as recited in Amended Claim 16. Rather, the cited portion of Yonehara appears to describe formation of nucleation surfaces 12-1, 12-2 on an amorphous insulating substrate. *See* Yonehara, col. 8, l. 65 - col. 9, l. 2. The nucleation surfaces are formed of a material different from the substrate. *Id.*

Further, Yonehara does not teach forcing nucleation sites on a surface of a seed crystal, as recited in Amended Claim 16. Instead Yonehara discloses providing a plurality of nucleation surfaces arranged separately on a substrate. *See* Yonehara, col. 8, l. 65 - col. 9, l. 2.

Accordingly, Yonehara does not disclose or suggest a method of producing a silicon carbide boule comprising forcing nucleation sites on a surface of a silicon carbide seed crystal to a predefined pattern, wherein forcing nucleation sites comprises forming a pattern of material other than silicon carbide on a surface of the silicon carbide seed crystal, thereby selectively exposing portions of the seed crystal

to define the nucleation sites in the selectively exposed portions of the seed crystal, as recited in Amended Claim 16.

The Official Action notes that Yonehara teaches the deposition of Si_3N_4 , patterning the layer of Si_3N_4 . Official Action, p. 3. Applicant notes that in the cited portion of Yonehara, the patterned regions of Si_3N_4 are the nucleation regions for the subsequently grown Si. As stated by Yonehara, "[o]n the Si single crystal wafer having thus provided nonnucleation surface comprising SiO_2 (S_{NDS}) and nucleation surfaces (S_{NDL}) of 50x100 comprising Si_3N_4 , Si single crystals were grown ..."

Yonehara, col. 17, ll. 17-20 (emphasis added). Thus, in contrast to the recitations of Amended Claim 16 which recite forming a silicon carbide boule from nucleation sites on a silicon carbide seed crystal, the cited portion of Yonehara discloses heteroepitaxial growth of one material (Si) on a different material (Si_3N_4).

Applicant submits that each of the recitations of Claim 16 are neither disclosed nor suggested by Balakrishna or Yonehara, either individually or in combination, for at least these additional reasons. Accordingly, Applicant submits that Claim 16 and the claims that depend from Claim 16 are patentable over Balakrishna and Yonehara and, therefore, requests withdrawal of the rejection.

Claims 16-21 Are Patentable Over Balakrishna and Uchida

As explained in the Preliminary Amendment filed with the present application, Uchida and Balakrishna cannot be properly combined. However, even if such references are combined, the combination does not teach or suggest each recitation of Claims 16-21.

As discussed above, Claim 16 has been amended. In particular, Amended Claim 16 recites a method of producing a silicon carbide boule having a substantially single polytype, comprising forcing nucleation sites on a surface of a silicon carbide seed crystal having the substantially single polytype to a predefined pattern. Moreover, Amended Claim 16 recites wherein the silicon carbide boule grows laterally above the material other than silicon carbide.

In rejecting Claim 16, the Official Action cited Example 8 of Uchida. Example 8 of Uchida teaches the formation of "a silicon carbide substrate in which a 6H hexagonal silicon carbide crystal is disposed between 4H silicon carbide crystals."

Uchida, par. [0089]. That is, Example 8 of Uchida relates to the stacking of silicon carbide crystal layers having different polytypes: "[t]herefore, a layered structure in which a 6H hexagonal silicon carbide crystal is disposed between 4H hexagonal silicon carbide crystals is thus formed." Uchida, para. [0092]. In sharp contrast, Amended Claim 16 recites a method of producing a silicon carbide boule having a substantially single polytype and forcing nucleation sites on a surface of a silicon carbide seed crystal having the substantially single polytype to a predefined pattern. Thus, according to Amended Claim 16, the silicon carbide seed crystal and the silicon carbide boule grown thereon each have the same substantially single polytype. As the cited portions of Uchida are directed to forming a structure that is completely different from a single crystal boule, Uchida does not disclose or suggest these recitations. Accordingly, Applicant submits that Amended Claim 16 is patentable over Uchida for at least these additional reasons.

Moreover, while Uchida discloses using a "graphite plate or graphite sheet having a predetermined mask pattern," Uchida, para. [0090], it appears that the "graphite plate or sheet" of Uchida is used only to selectively grow heteroepitaxial regions of 6H polytype in preparation for step-flow growth of stacked 6H and 4H layers, and that the graphite plate or sheet is removed prior to growth of a 4H and 6H film by step-flow growth: "Following the above, the aforementioned pre-treatment substrate is introduced into a CVD growing chamber, and a normal step-flow growth is developed." Uchida, para. [0090-0091]. *See also* Fig. 9 of Uchida, which illustrates step-flow growth of material having alternating layers of different polytypes.

In contrast, Claim 16 recites wherein the silicon carbide boule grows laterally above the material other than silicon carbide. Neither Balakrishna nor Uchida discloses or suggests such recitations, and accordingly, Applicant submits that Amended Claim 16 is patentable over Uchida and Balakrishna for at least these additional reasons.

Claims 17-21 are patentable over Balakrishna and Uchida at least per the patentability of Amended Claim 16. Accordingly, Applicant respectfully requests withdrawal of the rejection of claims 16-21 over Balakrishna and Uchida.

Claims 11-14 Are Patentable Over Balakrishna and Vichr

As explained in the Preliminary Amendment filed with the present application, Vichr and Balakrishna cannot be properly combined. However, even if such references are combined, the combination does not teach or suggest each recitation of Claims 11-14.

Claim 11 has been amended to include, inter alia, the recitations of cancelled claims 1 and 15. Amended Claim 11 recites as follows (emphasis added):

11. A method of producing a silicon carbide boule having a substantially single polytype, the method comprising:

forcing preferential nucleation sites on a surface of a silicon carbide seed crystal having the substantially single polytype to a predefined pattern; and

growing the silicon carbide boule utilizing physical vapor transport (PVT) so as to provide selective preferential growth of silicon carbide on the silicon carbide seed crystal corresponding to the predefined pattern;

wherein forcing preferential nucleation sites comprises forming a pattern on the surface of the seed crystal so as to provide regions of the seed crystal which extend beyond other regions of the seed crystal; and

wherein forming a pattern comprises forming a pattern of sidewalls in the exposed surface of the seed crystal; and

wherein growing the silicon carbide boule comprises preferentially growing silicon carbide from the sidewalls.

Vichr describes growing single crystal diamonds by CVD. *See e.g.* Vichr, col. 7, lines 25-27. As noted in the Official Action, Vichr discloses the growth of crystals from the top surfaces of nucleation structures formed in a seed plate. Amended Claim 1 has been amended to recite that forming a pattern comprises forming a pattern of sidewalls in an exposed surface of a seed crystal, wherein growing the silicon carbide boule comprises preferentially growing silicon carbide from the sidewalls. Applicant respectfully submits that neither Balakrishna nor Vichr discloses or suggests preferentially growing silicon carbide from sidewalls formed in an exposed surface of

a seed crystal. Accordingly, Applicant submits that Amended Claim 11 and Claims 12-14 that depend therefrom are neither disclosed nor suggested by Vichr and Balakrishna, either alone or in combination, and, therefore, requests withdrawal of the rejection.

Claims 11-14 Are Patentable Over Balakrishna and Beetz

Claims 11-14 were rejected over Balakrishna in view of Beetz. Initially, Applicant notes that Beetz relates to the growth of epitaxial films and not boules. According, for similar reasons as previously discussed with respect to the combination of Balakrishna and Vichr, Applicant submits that Balakrishna and Beetz cannot be properly combined to reject claims 11-14. However, even if such references are combined, the combination does not teach or suggest each limitation of Claims 11-14.

For example, as noted above, Claim 11 has been amended to recite that forming a pattern comprises forming a pattern of sidewalls in an exposed surface of a seed crystal, wherein growing the silicon carbide boule comprises preferentially growing silicon carbide from the sidewalls. In contrast, Beetz discloses epitaxially growing epitaxial layers on top surfaces of posts. *See, e.g., Beetz, Abstract.* Accordingly, Applicant submits that Amended Claim 11 and Claims 12-14 that depend therefrom are neither disclosed nor suggested by Beetz and Balakrishna, either alone or in combination, and, therefore, requests withdrawal of the rejection.

Double Patenting Rejections


Claims 1 and 55 were rejected under the judicially created doctrine of double patenting over claims 1 and 8 of U.S. Patent 6,706,114. As claims 1 and 55 have been cancelled, Applicant respectfully submits that such rejection has been mooted. Applicant notes that U.S. Patent No. 6,063,185 to Hunter and U.S. Patent 6,596,079 to Vaudo et al. are also assigned to the assignee of the present invention.

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Serial No.: 10/756,542
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CONCLUSION

In light of the above discussion, Applicant submits that the present application is in condition for allowance, which action is respectfully requested. If, in the opinion of the Examiner, a telephonic conference would expedite the examination of this matter, the Examiner is invited to call the undersigned attorney at (919) 854-1400.

Respectfully submitted,



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